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THE
AGRICULTURAL LEDGER.

1895—No. 2.

COAL.

[*DICTIONARY OF ECONOMIC PRODUCTS, Vol. II.,
C. 1414—1441.*]

REPORT ON INDIAN COALS:

*Result of examination in the Research Department of the Imperial Institute,
London.*

Other papers that may be consulted:

Indian Coal. Hand-Books of Commercial Products.
Indian Section. (No. 9) Imperial Institute Series.



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- (2) To secure the maintenance of uniform ledgers (on the plan of the Dictionary) in all offices concerned in agricultural subjects throughout India, so that references to ledger entries made in any report or publication may be readily utilised in all offices where ledgers are kept ;
- (3) To admit of the circulation, in convenient form, of information on any subject connected with agriculture or economic products to officials or other persons interested therein ;
- (4) To secure a connection between all papers of interest published on subject relating to economic products and the official Dictionary of Economic Products. With this object the information published in these ledgers will uniformly be given under the name and number of the Dictionary article which they more especially amplify. When the subject dealt with has not been taken up in the Dictionary, the position it very possibly would occupy in future issues of that work will be assigned to it.

E. C. BUCK,

Secretary to the Government of India.

THE
AGRICULTURAL LEDGER.

1895—No. 2.

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COAL.

[*Dictionary of Economic Products, Vol. II., C. 1414—1441.*]

REPORT ON INDIAN COALS.

*Result of Examination in the Research Department of the Imperial Institute,
London.*

The following report (furnished by SIR FREDERIC ABEL, Secretary and Director, Imperial Institute, London) gives the results of the technical examination, and, in some cases, those furnished by ultimate analyses, of the series of thirty different Indian coals sent by the Department of Revenue and Agriculture to the Imperial Institute.

The samples are drawn from twenty-three mines and collieries in seven different localities.

The results have been arranged as far as possible to correspond with the 'Hand-book on Indian Coals, No. 9, Imperial Institute series.' Thus, the figures in brackets correspond to those on the map in the Hand-book. A large number of analyses have been published in Ball's *Economic Geology of India*, but the method used is not mentioned, which is unfortunate, because to get comparative results a somewhat arbitrary method has to be employed, and in such cases exact details are all-important. Some of these analyses have been quoted in the official Hand-book, and in many cases there is a striking difference between them and those furnished by the samples under report. By communication with Mr. Ball, it has been ascertained that while the results given in his work are the best that could be obtained at the time, some of them being, in his opinion, perfectly trustworthy, they are not all to be relied upon alike as accurate.

Sampling.—Pieces of several pounds weight were sawn from the large blocks which form the specimens, and these were completely broken up and averaged. Whilst it must be confessed that it would have been more satisfactory to have had samples of about a hundredweight at command, from which to prepare average specimens for analysis, the specimens appeared, in the majority of cases, to be fair samples of the seams they represented.

Technical Analysis.—The percentages of fixed carbon, volatile matter, sulphur and ash were determined under the following conditions:—

About 0.2 grm. of the finely powdered coal was weighed out into a tared platinum crucible; the latter was supported 12 inches above the working bench, and heated over a No. 8 Fletcher Bunsen burner, working at full power, for two minutes; it was then immediately subjected to a blow-pipe flame for two minutes longer, being kept at a bright red heat. After cooling in a desiccator, it was weighed and the loss reckoned as volatile matter,

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Technical Analysis.	<p>which of course included moisture. The well-fitting lid of the crucible was not removed during the whole of this process. In the case of caking coals a very small quantity of soot sometimes remained on the under-side of the lid and escaped combustion. These determinations were made in duplicate, and passed if the difference was not more than 0.3-0.4 per cent. at this stage. The crucible was then put in a muffle-furnace with the lid half-off, and heated until nothing but ash remained, when it was cooled in the desiccator and weighed. The loss was reckoned as fixed carbon and the residue as ash; the colour of the ash will be found recorded in the tables.</p>
Ultimate Analysis.	<p>For the estimation of the sulphur about 1.5 grms of coal were fused in a platinum dish, with 30 grms of the following fusion-mixture:—sodium chloride, 4 parts; potassium nitrate, 3 parts; sodium carbonate (dry), 1 part. The mixture was slowly heated, and after a short time it deflagrated and became liquid; this liquid when cooled solidified to a white cake, which was dissolved in boiling water; the solution was filtered acidified with hydrochloric acid, and while quite hot, precipitated with barium chloride. By keeping the beaker and its contents warm, on the water bath, for three or four hours, the precipitate of barium sulphate was obtained in a granular form, very suitable for filtering. Most of the filtering was done through a felt of asbestos in the bottom of a perforated platinum crucible with the help of a water pump, this being a modification of Gooch's method. Careful test-experiments showed that in point of accuracy this method was at least equal to the one ordinarily in use, <i>viz.</i>, that of igniting the precipitate of barium sulphate in a crucible, and is, for speed, much to be preferred. These estimations were made in duplicate, a difference of 0.3 per cent. being considered quite allowable, after considerable experience. In some cases the sulphur left in the coke was estimated.</p> <p><i>Ultimate Analysis.</i>—This was conducted in the usual manner; the coals were first dried in a current of hydrogen gas at 120° C. for half-an-hour. This was done by pushing the platinum boat containing the weighed quantity of coal into the middle part of a long piece of wide glass tubing, which itself was passed through the walls of a saucepan. Hydrogen was let in at one end and allowed to diffuse through a small piece of fine tubing, packed with cotton wool, inserted in a cork at the other end. A burner was lighted under the saucepan, and a thermometer fixed into a hole in the lid; a very convenient air-bath was thus obtained. The coal, after being dried, was then burned in the usual way in a piece of hard glass tubing. The tube used was filled to a length of 15 inches with copper oxide (from wire), and to 4½ inches with lead chromate, these materials being kept in position by plugs of fine copper gauze. The total length of the tube was about 34 inches. It will be noticed that the amount of ash, as determined in the combustion operation, was in some cases distinctly higher than when estimated by the technical method. This is doubtless due to the presence of iron and other minerals in the ash, which are left in a higher state of oxidation after being heated in oxygen.</p> <p>The following is a tabular statement of the results arrived at, together with descriptions of the character of each particular coal:—</p>

Results of Technical Examination.

COAL.		Report on Indian Coals					
Technical Analysis.	Results of						
	Province.	Mine.	Indian Invoice Number.	Imperial Institute Number.	Fixed Carbon. %	Volatile matter. %	Sulphur. %
	Assam	Makum	1828	3032	53'28	45'45	1'02
	"	Cherra Punji . .	96	1445	49'54	45'72	3'98
	"	Maoifong	97	1446	49'79	47'25	3'08
	Baluchistan	Khost	93	1441	49'58	45'27	4'82
	"	"	94	1442	41'50	48'94	0'74
	Bengal	Kumardubhi . .	99	1448	51'48	44'67	0'53
	"	Raneegunge . .	1661	2865	42'05	45'60	1'58
	"	Barakar	652	1996	53'49	28'18	0'62
	"	Karharbarce Jo- giland.	636	1980	56'45	32'78	0'51
	"	Do. Lower } Seam.	639	1983	64'80	27'83	0'42
	"	Do. Upper } Seam.	641	1985	66'80	27'85	0'40
	"	Sodepore	1658	2862	49'05	41'57	0'29
	"	Liakdee	1659	2863	57'70	33'08	0'53
	"	Nimcha	1660	2864	42'50	42'86	0'32
	"	Kooldeah	1662	2866	61'20	26'72	1'50
	"	Searsole	1663	2867	49'41	39'30	1'63
	"	Madhubpur . .	1664	2868	38'80	44'08	1'54
	"	Sanctoria . . .	1668	2872	49'32	39'94	1'53
	"	Derhagar . . .	1665	2869	42'71	45'26	1'51
	Burma	Burma Coal Co. .	3531	6157	33'57	57'93	0'33
	"	" "	3532	6158	3'58	28'05	0'11
	Central India. . . .	Umaria	256	1605	59'65	16'72	0'32
	" " " "	" " " "	322	1671	55'97	17'43	0'43
	Central Provinces	Mohpani	1648	2852	42'46	33'24	0'50
	" "	Warora	316	1665	41'40	45'10	0'94
	" "	" " " "	318	1667	40'97	46'25	1'21
	" "	Gadawarra . . .	1649	2853	42'61	37'26	0'39
	" " " "	" " " "	1650	2854	41'00	39'35	0'44
	" " " "	" " " "	1651	2855	45'35	45'42	0'43
	Hyderabad	Hyderabad . . .	87	1436	43'55	43'74	0'29

examined at the Imperial Institute, London.				COAL
Technical Examination.				Technical Analysis.
Ash. %	Colour of Ash.	Caking pro- perties.	Other characteristics of the sample.	
1'07	Pale chocolate .	Does not cake .	A glistening black coal, clean to handle, easily broken, conchoidal fracture.	
4'74	Dark red . . .	Cakes . . .	A dull black coal, dirty, very hard, with cuboidal fracture.	
2'96	Yellowish brown .	" . . .	Bright and clean, with fossil resin in many places.	
5'15	Terra cotta . . .	" . . .	Clean, bright and hard, but disintegrating with a white efflorescence, and with evolution of sulphuretted hydrogen.	
9'56	Yellowish brown .	" . . .	Clean, bright and hard, with obtuse fractures.	
13'85	Grey	" . . .	Layers of dull and bright coal, clean rounded fractures.	
12'35	Fawn colour . . .	" . . .	Bright, hard and dirty.	
18'33	Greyish white . .	" . . .	Dull black, dirty, very hard.	
10'77	White	" . . .	Laminated, very clean, cleaves in small cubes.	
7'37	Dark yellow . . .	Does not cake .	Dull black, clean, not very hard.	
5'35	Yellowish brown .	" " . . .	Dull black, hard, clean, breaks into cubes.	
8'48	Light yellow . . .	Cakes . . .	Bright, dirty, fairly hard.	
8'62	White	" . . .	Mixed dull black and glossy, the latter crumbles readily, clean.	
14'64	Brownish yellow .	" . . .	Dull and glossy laminæ, clean and hard.	
12'08	White	" . . .	A dull black coal, clean and hard.	
11'29	Lemon yellow . .	" . . .	A glossy coal, hard, but with soft patches.	
17'12	Brownish yellow .	" . . .	A dull coal, laminated, hard with soft patches, clean.	
10'74	Yellowish grey . .	" . . .	A dull coal but with bright patches, hard and clean.	
12'03	Fawn colour . . .	" . . .	A clean bright coal,* cleaving in layers.	
8'50	White	Does not cake .	Dull black, clean and hard, with rounded surfaces and fractures.	
68'39	"	" " . . .	Dull black with glossy patches, very soft and soapy to touch, clean.	
23'63	"	" " . . .	A clean dull coal with irregular cleavings, easily broken.	
26'60	Greyish white . .	" " . . .	Dull, soft, clean and contains fossil resin.	
24'39	Brownish yellow .	" " . . .	Dull, laminated, very hard, fairly clean.	
13'50	White	" " . . .	Dull with bright patches, clean and rather soft.	
12'78	"	" " . . .	A clean silky coal, easily broken, cleaving in cubes.	
20'13	"	Cakes . . .	Dirty, alternate layers of dull and very hard coal, and bright coal easily broken.	
19'65	Yellowish brown .	"	Dull, hard and clean, with occasional glossy layers. Irregular fracture, extremely hard, dull, clean coal, with thin streaks of glossy coal.	
9'23	Light yellow . . .	"		
12'71	Yellowish brown .	Does not cake .		

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Quality of different specimens. Assam.	<p>The following observations are offered on the samples included in this series:—</p> <p>The Assam coals are of a high order, the ash being particularly low, but the sulphur in two cases is rather high.</p> <p>Mr. Ball (p. 105 of his Book) gives fixed carbon, 60 per cent.; volatile matter, 36·2 per cent.; ash, 3·8 per cent. as furnished by <i>Makum</i> coal, and speaks very highly of its qualities. It will be observed to differ from the other two Assam coals, being non-caking. Mr. Ball (p. 109, and Handbook p. 52) gives volatile matter, 37·1; fixed carbon, 62; and ash, 0·9 as the results furnished by <i>Cherra Punji</i> coal; results which differ from those furnished by the Institute sample. The Handbook gives the results of examination of two samples of <i>Maoflong</i> coal by Mr. F. R. Mallet, of the Geological Survey of India, both differing widely from the results furnished by the Institute samples. The ash in one of them (<i>Maobéláká</i>) is only 1·8 in the moist coal, while in the other (from <i>Dédum Hill</i>) it amounts to 31·6, and in the Institute sample it is 2·96.</p>
Baluchistan.	<p><i>Baluchistan—Khost.</i>—The Handbook (p. 45) gives results which are in fair accordance with those furnished in the fifth sample in above table. One of the samples had become already partly disintegrated by oxidation of the pyrites contained in it.</p>
Bengal.	<p><i>Bengal.</i>—The samples of coal from the various mines in Bengal vary somewhat considerably in quality among each other. Thus, the ash varies between 5 per cent. to 18 per cent. and the sulphur between 0·25 per cent. and 1·5 per cent. Several of them are good caking coals, and the samples from <i>Jogiland</i> are the only non-caking coals from Bengal. The coal from the upper seam at <i>Karharbari</i> is the best, and those from <i>Kumardubhi</i>, <i>Sodepore</i> and <i>Liakdee</i> are also of high quality. No previous examination appears to have been made of the <i>Kumardubhi</i> coal (see p. 31, Handbook). Mr. Ball gives the following as average numbers furnished by examination of thirty-one samples of the <i>Raneegunge</i> coal, fixed carbon, 53·2; volatile matter, 25·83; ash, 16·17. Mr. Ball also gives an analysis of <i>Barakas</i> (<i>Antargaon</i>), which agrees well with the results furnished by the Institute sample.</p>
	<p>Dr. Walter Saise, F.G.S., Manager of the East Indian Railway Collieries, has published a paper on the <i>Karharbari</i> coalfield, to which Mr. Ball makes reference (p. 79). He gives the results of examination of samples from four different seams, which do not vary very greatly among each other, but it is difficult to say to which of these the sample of <i>Jogiland</i> seam sent to the Institute corresponds. The specimens marked 'Lower' and 'Upper' seam yield results, both by technical examination and ultimate analysis, fairly in accordance with those of Dr. Saise.</p>
	<p>It does not appear that any previous examination has been made of coal from the following seams:—<i>Sodepore</i>, <i>Liakdee</i>, <i>Nimcha</i>, <i>Khooldeah</i>, <i>Searsole</i>, <i>Madhubpur</i> and <i>Derhagar</i>. The <i>Sanctoria</i> seam is stated in the Handbook to have acquired a high reputation as a gas coal, and for marine purposes. The sample sent to the Institute furnishes, as percentage of ash, 10·74, and the sulphur in it was also somewhat high, while the percentage of volatile matter was rather below the samples from <i>Sodepore</i> and <i>Mincha</i>, both of which contained comparatively small portions of sulphur.</p>
Burma.	<p><i>Burma.</i>—Of the two samples received from Burma, the one is a non-caking coal, containing, however, a high proportion of volatile matter. The sulphur is low, and the ash, which is white, is somewhat high. The other sample sent from Burma cannot be described as coal. In appearance it is not unlike some of the denser forms of lignite and of boghead canal, but it is of very much higher specific gravity, and contains no less than 68 per cent. of mineral matter (ash), consisting almost entirely of alumina. The</p>

examined at the Imperial Institute, London.	COAL.
<p>volatile matters amount to less than 4 per cent. It is evident from the results of examination (which have been confirmed by Dr. Hugo Muller, F.R.S., and Mr. B. Brough, A.R.S.M., Members of the Advice Committee) that the fuel-value of this material is very small indeed. It is even doubtful whether it could be used in its own locality, with any advantage, for the production of Siemens gas, and its poverty in bituminous matter precludes its application to the purposes for which the boghead mineral is utilised in this country.</p> <p>The results of the examination of several samples of coal supplied by the Burma Coal Company are given in the Handbook (p. 61). In these the moisture ranges from 9 to 18 per cent., the fixed carbon from 24 to 47, the volatile matters from 20 to 37, and the ash from 2 to 39 per cent.</p>	<p>Quality of different Coals. Burma.</p>
<p><i>Central India.</i>—The two samples of coal from Central India (<i>Umaria</i>) are very similar. They are non-caking coals, containing only about 17 per cent. of volatile matter; the sulphur is not high, but the ash amounts to 23.6 and 26.6 per cent. In the Handbook (p. 41) the results of examination are given, which were furnished by the Geological Department of India, from a sample of <i>Umaria</i> coal, in 1884, and these show that the samples now examined differ from it greatly in character. The ash amounted to only 8.12 per cent. in the air-dried coal.</p>	<p>Central India.</p>
<p><i>Central Provinces.</i>—On page 39 of the Handbook, the coal from <i>Mohpani</i> Colliery (Central Provinces) is stated to be above the average quality of Indian coals, and almost equal to the best Bengal coals. The sample sent to the Institute does not correspond with this description, as, although the sulphur is comparatively small, it was found to contain nearly 25 per cent. of ash. The volatile matter was found to be very much higher than indicated by the proximate results given in the Handbook. The coal from <i>Warora</i> Colliery was made the subject of a paper read before the North of England Institute of Mining and Mechanical Engineers in 1890, by Mr. C. C. Binning. The results of examination of two samples of coal given in that paper correspond fairly with those of the examination of the two Institute samples. The coal from <i>Gadawarra</i> does not appear to have been made the subject of previous examination. It will be seen that one of the samples contains a small proportion of ash, as compared with the majority of Indian coals, and that the sulphur is also not high. Judging from the behaviour of these specimens, the <i>Gadawarra</i> coal appears to be a good caking coal.</p>	<p>Central Provinces.</p>
<p><i>Hyderabad.</i>—Only one sample of coal from <i>Hyderabad</i> has been received. In this the ash was not very high for Indian coal, and the proportion of sulphur was small. No means exist of identifying the particular district from which this sample was derived. In Percy's Metallurgy (Fuel) the analyses are given of two specimens of coal from <i>Hyderabad</i>: they yielded a somewhat higher percentage of fixed carbon, the sulphur was higher in both (0.51 and 0.81), and the ash was similar in amount to that in the Institute sample.</p>	<p>Hyderabad.</p>

The following table gives the results of analysis of 12 of the best samples of coal included in the series sent to the Imperial Institute. The composition of English, Welsh, and Scotch coals (being in each case the

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Results of Analysis.

mean of several analyses), and of a specimen of coal from New South Wales, is also given in tabular form for purposes of comparison 1—

Results of Analysis.

Indian coal.

DISTRICT OR PROVINCE.	Mine.	Indian Invoice Number.	Carbon.	Hydrogen.	Ash.	Moisture.	Sulphur.	Nitrogen, Oxygen, etc.
Assam	Makum	1823	77'31	5'43	1'37	3'07	1'02	11'90
"	Cherra Punji	96	77'75	5'80	4'74	1'45	3'98	6'25
"	Maofong	97	75'05	5'17	3'23	3'15	3'38	10'34
Baluchistan	Khost	93	71'38	4'97	5'57	3'89	4'82	9'41
"	"	94	70'58	5'55	10'04	2'46	0'74	10'03
Bengal	Kumardabi	99	70'43	4'70	13'85	1'86	0'53	8'63
"	Lower Seam	639	80'75	4'32	7'37	1'23	0'42	5'91
" Karharbarce	Upper Seam	641	81'53	4'59	5'35	1'26	0'40	4'88
"	Sodepore	1058	71'09	4'97	9'03	3'54	0'29	10'18
"	Liakdee	1659	75'33	4'60	9'29	2'23	0'53	8'02
Burma	Burma Coal Company	3531	66'23	4'64	9'28	11'55	0'33	13'95
Central Provinces	Gadawarra	1051	67'05	4'37	9'73	7'07	0'43	10'75

British and Australian coal.

Composition of British and Australian Coal.

(For purposes of comparison.)

Coal.	Carbon.	Hydrogen.	Oxygen and Nitrogen.	Sulphur.	Ash.	Water.
Northumberland: Caking (mean of 4 samples)	80'29	5'32	11'79	0'91	1'68	Exclusive of water.
Welsh: Caking (mean of 3 samples)	83'00	5'75	7'84	0'77	2'64	
Welsh: Non-caking (mean of 4 samples)	86'92	4'39	4'30	1'28	3'42	
South Staffordshire: Caking (mean of 4 samples)	75'41	4'62	16'29	0'71	2'97	
Scotch: Non-caking (mean of 3 samples)	79'21	5'23	13'28	0'90	1'38	
New South Wales	77'65	4'94	10'63	0'58	3'28	2'95

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G. I. C. P. O.—No. 18 R. & A. D.—1-7-95.—A. E. des.

All communications regarding THE AGRICULTURAL LEDGER should be addressed to the Editor, Dr. George Watt, Reporter on Economic Products to the Government of India, Calcutta.

The objects of this publication (as already stated) are to gradually develop and perfect our knowledge of Indian Agricultural and Economic questions. Contributions or corrections and additions will therefore be most welcome.

In order to preserve a necessary relation to the various Departments of Government, contributions will be classified and numbered under certain series. Thus, for example, papers on Veterinary subjects will be registered under the Veterinary Series. Those of more direct agricultural or industrial interest will be grouped according as the products dealt with belong to the Vegetable or Animal Kingdom. In a like manner, contributions on Mineral and Metallic subjects will be registered under the Mineral Series.

This sheet and the title-page may be removed when the subject-matter is filed in its proper place, according to the letter and number shown at the bottom of each page.